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A case report of Wesselsbron disease in sheep and a horse

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Introduction:
Wesselsbron disease (WBD) is an insect borne viral infection of sheep, goats and cattle that derives its name from the district where it was first isolated from the organs of a lamb in 1955. It is reported to cause mortalities in new-born lambs and kids, subclinical infection in adult animals and occasionally abortion in ewes. Sheep and cattle foetuses can develop central nervous malformation resulting in musculo-skeletal contracture and rigidity (arthrogryposis). When humans are infected, a non-fatal influenza-like illness has been described.[1]

In February and March the State Veterinarian in Beaufort West submitted formalin fixed tissue to the Western Cape Provincial Veterinary Laboratory for histological evaluation. The samples originated from two unrelated cases. Merino lambs and mature ewes were dying with varying degrees of icterus being the most significant post mortem finding. Histological evaluation of the tissue revealed severe damage to the liver. The liver sections were characterised by single cell necrosis to severe extensive areas of coagulative necrosis. The remaining viable hepatocytes showed cellular swelling, fatty change, megalocytosis and anisonucleosis with accompanying Kupffer cell hyperplasia, mild fibrosis and bile duct proliferation. These lesions are suggestive of a toxic insult to the liver. Some examples of known hepatotoxic plants include *Hertia pallens* (Springbokbossie), *Pteronia pallens* (Scholtz-bossie), *Asaemia axillaris* (Vuursiektebossie) and even Aflatoxicosis which is a mycotoxicosis caused by *Aspergillus flavus*[2]. Presumptive diagnoses of plant toxicity were made, but considering the history and after consultation with Dr Pienaar, the wax embedded tissues were submitted to the Pathology department of the Veterinary Faculty at Onderstepoort for WBD immunoperoxidase staining. Serum collected from an affected lamb was also sent to the Onderstepoort Veterinary Institute for WBD antibody detection by complement fixation testing. Diffuse, intense positive staining for WBD of the liver samples were reported and the lamb's serum had very high antibody levels against WBD.

Another interesting case involving a horse from Bonnievale were submitted in April to the Western Cape Provincial Veterinary Laboratory. Clinical signs included pyrexia at first, which progressed over 4 days from hind limb paresis, incoordination and weakness to complete paralysis. Euthanasia was elected and the horse was submitted for post mortem examination where no significant macroscopic lesions were found. Histological evaluation of nervous tissue revealed a severe, diffuse mononuclear meningo-encephalitis with widespread perivascular cuffing around the bloodvessels in the neuropil as well as meningitis. Multifocal neuronal necrosis with gliosis was a feature of the grey matter. No significant lesions were observed in any of the other parenchymal organs examined histologically. Classically this presentation is associated with numerous viral encephalitides, prompting ancillary diagnostic investigation. Immunoperoxidase staining for Equine Herpes, Equine Encephalosis, Rabies and African Horse Sickness viruses were all negative. Virus isolation and PCR (polymerase chain reaction) on fresh spleen and lung samples for Equine Encephalosis, African Horse Sickness and Equine Herpes viruses were negative. Wesselsbron virus infection was confirmed by dr. M Venter from the Department of Medical Virology, Faculty of Health Sciences, University of Pretoria using RT-PCR (reverse transcription polymerase chain reaction) on formalin fixed neural tissue.

Discussion:
Interestingly, mature sheep were affected in the one case, with no abortions reported in either of the two cases. Classically WBD causes sporadic abortion and mortalities in newborn animals. The histological appearance was deceptively reminiscent of a toxic insult to the liver.

The described case in the horse was purportedly only the second confirmed case of WBD in this species, the details of which will be published elsewhere by dr. Venter. (personal communication) The other case recovered after showing neurological signs for approximately 21 days.
This case report serves as a reminder of a relatively well-known disease presenting itself in a new species (the horse) as well as in a manner that has not yet been described fully before (mature sheep).
Owners are urged to be cognizant of this disease especially with the zoonotic potential it holds and the manifestation in species and age groups of animals previously considered less or not susceptible. A live attenuated vaccine is available for yearly use in ewes. Pregnant animals may under no circumstances be vaccinated with Wesselsbron disease vaccine due to the teratogenic effect thereof on the foetus.

Acknowledgments:
The authors wish to thank Drs J Pienaar and J Giliomee for submitting these interesting cases, the histopathology section at Onderstepoort Veterinary Faculty for performing and reporting the immunoperoxidase staining on the cases, the virology department at the Onderstepoort Veterinary Institute for performing serology and virus isolation as well as dr. M Venter from the University of Pretoria for the reporting on the WBD in the horse.

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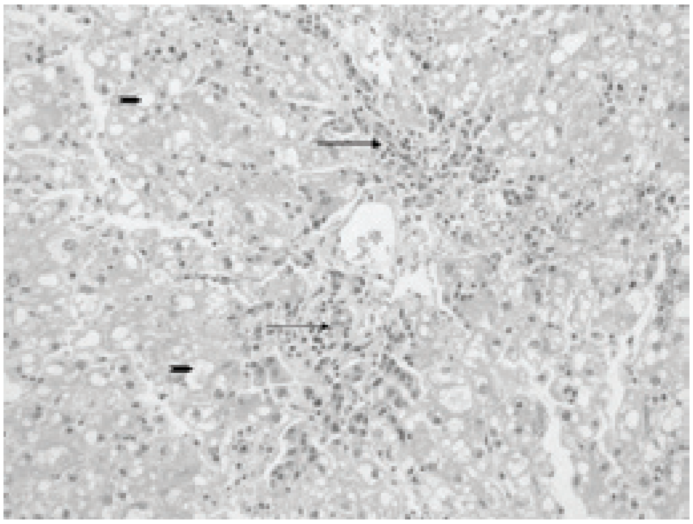

Liver: Bile duct proliferation. ⟶ , fatty change ➤
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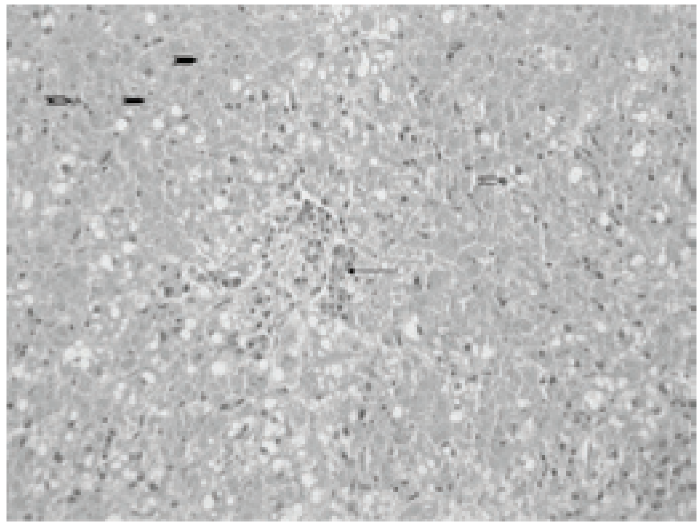
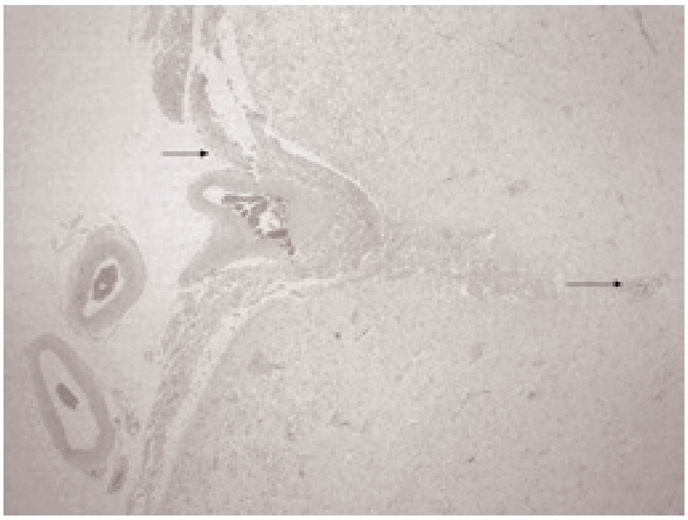
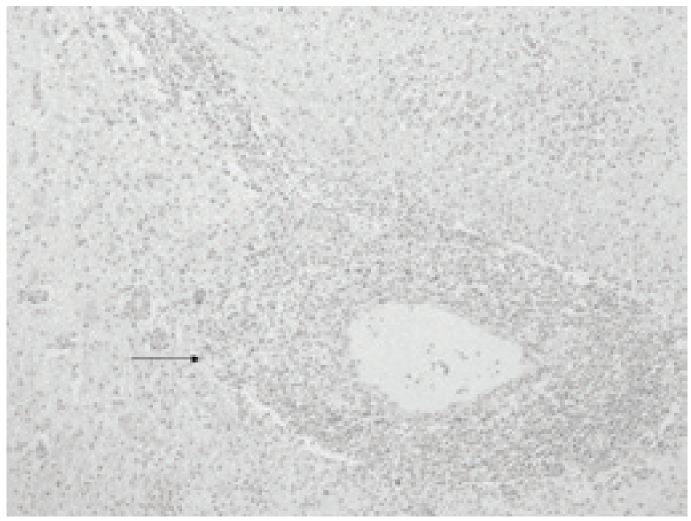


Liver: Coagulative necrosis of hepatocytes, ➤
Kupffer cell hyperplasia ⇨ , fatty change and bile duct proliferation. ⟶
(200x)



Brain:
Mononuclear meningo-encephalitis ⟶
(100x)



Brain: Extensive perivascular cuffing and encephalitis ⟶
(200x)

Carbon Sequestration and Trading: An Opportunity for Farmers and Landowners to Earn Additional Income

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This article aims to give a brief overview on the concept of carbon sequestration as a short-term strategy to help mitigate global warming and climate change. It also provides a short outline of the challenges and shortcomings of carbon sequestration projects as well as highlights the possibilities of farmers enrolling in such projects thus earning additional income.

Global Warming and Climate Change

The terms global warming and climate change are used interchangeably. Climate change in essence occurs as a result of global warming. Global warming refers to the warming of the globe in recent decades and its projected continuation and implies a human influence. Shah (undated) agrees that climate is changing; the earth is warming up and there is now overwhelming scientific consensus that it is happening and is human induced. Greenhouse gases released into the atmosphere by human activities such as fossil fuel burning, continued deforestation and tillage practices are releasing carbon dioxide, trapping heat and causing air and ocean temperatures to rise thereby resulting to changes in climate. The consequences of such a dramatic rise in temperature vary from elevated sea levels threatening coastal regions; increased severity of extreme weather events such as hurricanes, flooding, and drought; higher incidence of heat stress, respiratory illness among people in urban areas and widespread migration of infectious and tropical diseases (Dunne, 2003). The major impact in South Africa (according to the Initial National Communications in South Africa) would be in the health sector, maize production, plant and animal biodiversity, water resources and rangelands (Friedenthal *et al*, 2004)

The South African Energy Industry is heavily reliant on fossil fuels as a primary source of energy with coal providing 75 percent of the energy supply. It is followed by agriculture, industrial processes and the waste sector at 9,3 percent, 8 percent and 4,3 percent respectively. This has led to the energy sector being cited as the major contributor to global warming and climate change. These sectors result in emissions of 8,5 Mg CO^2 equivalents per capita, which, accounts for almost half (49 per cent) of Africa's total carbon dioxide emissions (Friedenthal *et al*., 2004).

The Kyoto Protocol and Declaration of Carbon Sequestration as a Strategy to Help Mitigate Global Warming and Climate Change

Having recognized the potential danger of a changing global climate, in December 1997, at the third conference of parties (COP-3), the Kyoto Conference on climate change took place. The Intergovernmental Panel on Climate Change (IPCC) to address global warming and climate change took place in Japan, Kyoto. After this conference, it then became the IPCC's norm to hold conferences timeously and these were referred to as conferences of parties (COP's). The industrialized countries in this conference agreed to specific targets for cutting their emissions of greenhouse gases. These countries committed to an overall reduction of emissions of greenhouse gases by 5,2 percent below 1990 levels for the period 2008 to 2012 usually referred to as the first commitment period. The agreement allows industrialized countries (Those countries specifically listed in Annex 1 to the Kyoto Protocol) to offset their carbon emissions by investing in projects that reduce greenhouse gas emissions in developing countries (Those countries specifically listed in Non Annex 1 to the Kyoto Protocol), where costs of establishing such projects are much lower (United Nations Framework Convention on Climate Change (UNFCCC, 2003 and Fenhann, 2005, cited by Jindal, 2006). Each Annex 1 country agreed to a different greenhouse gas emissions level within the collective target. These targets are legally binding. This means, should Annex 1 countries exceed their greenhouse gas emissions targets, they can always buy credits from non Annex 1 countries to offset the debit (Bezuidenhout, 2007). Should the party at default not be able to offset the debit, the Enforcement Branch of the Compliance Committee shall declare the party as one in non-compliance and shall therefore require the party to make up the difference between its emissions and its assigned amount during the second commitment period. In addition, the Compliance Committee shall require the party to submit a compliance plan of action and suspend the eligibility of the party to make transfers under emissions trading until the party is reinstated (Anonymous, undated).

Numerous countries agreed to the terms of the Kyoto Protocol to the UNFCCC aimed at combating global warming and climate change. To date, 178 states have signed and ratified the Kyoto Protocol. These include such countries as South Africa, Brazil, China, Canada, New Zealand; Australian *etc* but excluding the USA. South Africa is currently participating in the Clean Development Mechanism of the Kyoto Protocol whose mandate is to allow developing countries to achieve sustainable development and to contribute to the ultimate goal of the Kyoto Protocol by assisting developed countries to achieve compliance with their emission limitation and reduction commitment. The CDM projects in South Africa include landfill gas capture, fuel switching and low income housing energy projects. This market-based system allows for individual firms and countries to select the most cost effective solutions to reduce their green house gas emissions.

Several conferences with regard to strategies to mitigate global warming and climate change were held and it was only after a series of discussions that carbon sequestration through afforestation; reforestation and land use change, with soils and forests acting as carbon sinks was finally approved as one of the short-term strategies that can be considered in an attempt to meet emissions reduction targets during the first commitment period (2008-2012) of the Kyoto Protocol. This declaration was made at the seventh conference of parties (COP-7) that was held in Marrakech, in 2001(Mooney *et al*., 2002; Smith, 2004).

Challenges Facing Registration and Implementation of Carbon Sequestration Projects

For farmers to trade in carbon markets, their project proposals must meet certain requirements, *viz*, additionality, permanence, duration and leakage (UNFCCC, 1998 and Watson *et al*., 2002 cited by Mooney *et al*., 2002), verifiability and measurement. The applicability of these concepts in carbon sequestration projects and their meanings are presented as follows; additionality means that carbon credit generated through carbon sequestration must be additional to any changes in carbon that would have occurred under a “”business as usual” scenario and its calculation varies from project to project. Permanence in carbon projects refers to the length of time that carbon is sequestered and maintained in a sink such as forest or agricultural soil. Carbon sinks may be relatively temporary or permanent and there is a tendency of the carbon sequestered returning to the atmosphere within years or decades should the action causing the sequestration be stopped or reduced. Leakage in carbon sequestration projects concerns the issue of project activities causing economic agents to take actions that would increase greenhouse gas emissions elsewhere. Verifiability and measurement in carbon credits means they must be quantifiable and their existence proved or validated. It is only after having met these requirements that a project for carbon sequestration can be approved.

However, there have been a number of challenges to the long-term value of carbon sequestration projects as mitigation efforts to offset green house gas emissions from industrial sources (Sampson, 2004). Several ways to calculate additionality and baselines have been proposed and these vary from the base year, a historic year and a business as usual baseline and opinions differ in terms of their efficiency. However, there are fears that project developers will game the system and attempt to achieve credit for carbon that is either not present with or without the project. In the case of land-based projects, there are differences between soils, sites and practices, but the ranges of variability are well known to scientists and practitioners. As a result, exaggerated baseline projections or claims of emission reductions or carbon sequestration will draw technical criticism. Methods to review reports and identify, adjust or justify such claims will therefore be needed to maintain the credibility of any registry (Sampson, 2004). With regard to leakage, several programs offer little or no guidelines at all so it is likely that it is ignored. However, Engelbrecht *et al* (2004) are of the view that such costs i.e. the (transaction) costs of bringing the carbon sequestered to market, and repeatedly proving that it exists can be higher than the value of the carbon itself, meaning that profitability and economic viability of carbon trading through carbon sequestration is still questionable. It is important therefore for projects seeking recognition for their emissions reduction or carbon sequestering value to demonstrate that they have achieved real reductions in atmospheric greenhouse gases, that those reductions can be maintained for an appropriate time period, and that project claims can be verified by an independent observer if necessary (Sampson, 2004). Means to address some of these requirements and challenges are still being devised and there is still no consensus reached on the guidelines to address them.

Income Generating Opportunities for Landowners and Farmers in the Western Cape Province of South Africa

Despite the above challenges and limitations, opportunities do exist for farmers to participate in carbon markets. Landowners in the southeastern parts of the Western Cape are being given an opportunity to test the feasibility of restoring degraded veld using *spekboom* and to eventually cash in on the fledgling carbon credit market. *Spekboom* scientifically known as *Portulacaria afra* is a tree species which has the ability to bind carbon from the atmosphere (Bezuidenhout, 2007) and could provide an income for landowners and farmers, while restoring land degraded by nonsustainable grazing practices (Bezuidenhout, 2007).

The success of *Portulacaria afra* as a carbon sink is strongly linked to its physiology (Palmer, 2004). During photosynthesis, *Portulacaria afra* fixes carbon from the air and metabolizes it into its root system and foliage. The organic matter left over by the plant in dead leaves has a high carbon content (Bezuidenhout, 2007). The carbon is then sequestered in four carbon pools, viz. above ground plant biomass, root biomass, soil carbon and leaf litter (PACE, undated). However, *Portulacaria afra*’s physiology and distribution characteristics require further understanding and such aspects would need to be accounted for should *Portulacaria afra* become a focal point for carbon trading schemes. Other species that can be considered for afforestation include *Euphobia bothae, Euphobia coerulescens, Aloe* and *Crassula* specimen. These are also fast growing endemic native specimen that can be considered as carbon sinks in the fight against global warming and climate change (Palmer, 2004).

For carbon sequestration through *Portulacaria afra,* the Rhodes Restoration Research Group (R^3G) will do the monitoring of soil carbon levels before and after restoration. This will assist in an opportunity for marketing carbon credits. In order to trade on the carbon market, the seller requires certification to verify the validity of the carbon credits. The R^3G work is also to provide scientific evidence of the amount of carbon being stored in the plant and soil matter by the *Portulacaria afra* and so provide credibility to the restoration project (Bezuidenhout, 2007). However, farmers can also consider shifting their land use practices and adopting conservation tillage to sequester carbon. Old wheat and maize lands can in this instance be used as sinks for sequestering carbon. According to Mills *et al*. (2003), wheat fields have the ability to bind 40 tons of carbon per ha in the renosterveld and adoption of no till and minimum tillage methods can therefore enhance carbon sequestration.

Conclusions and Recommendations

Carbon trading is a new concept in the agricultural sector and as a result there is limited awareness on the opportunities farmers can explore and take advantage of, potential risks within the market as well as the methodology to be followed when one wants to participate. The strategies that can be considered involve carbon sequestration through the planting of *Portulacaria afra* and the conversion to conservation farming. Calculations of baseline methodologies, leakage and measurement as well as verification of the amount of carbon sequestered seem to impose challenges in the realization of the benefits from carbon trading. Despite these challenges, opportunities do exist for farmers to participate in carbon markets. However, the implementation of such strategies i.e. carbon sequestration through afforestation using *Portulacaria afra*, *Euphobia bothae, Euphobia coerulescens, Aloe* and *Crassula* specimen and the conversion to conservation farming especially the latter (as the former is still in a pilot phase) could be considered pending further investigations into their profitability and economic viability. The methodology on how to participate in the carbon trade market through afforestation and conservation tillage will be outlined after the profitability and economic viability of the strategies have been determined.

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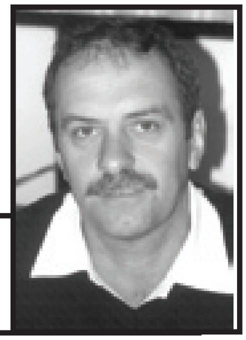
Grondverskille moét in ag geneem word met stikstofbemestings-beplanning



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1. Inleiding

Grond is een van die mees belangrike faktore wat die groei en opbrengs van gewasse beïnvloed. Nie net absorbeer die wortelstelsel van gewasse essensiële voedingselemente uit die grond nie, dit dien ook as medium waarin water geadsorbeer (vasgehou) word vir latere absorbsie deur plantwortels. Menige grondfaktore, soos voginhoud, deurlugting, verdigting, temperatuur, pH, konsentrasie (hoeveelheid) en beskikbaarheid van plantvoedingselemente ens, kan gewasprestasie beïnvloed (Brady, 1990; Tisdale & Nelson, 1975; FSSA, 1989). Stikstof, vaarvan plante groot hoeveelhede benodig, word baie sterk deur verskeie grondfaktore beïnvloed. Ontwikkeling van stikstofbemestingsprogramme is dus nie eenvoudig nie en word sterk deur grondfaktore beïnvloed, faktore wat op hul beurt weer die produksiepotensiaal van die gewas, en sodoende ook die N behoefte van die gewas, bepaal. Die N-mineralisasiepotensiaal van die grond dra verder by tot die kompleksiteit van stikstofbemestingsprogramme. 'n Navorsingsprojek te Langgewens waar gepoog word om die N-bemestingsnorme van koring in verskillende wisselboustelsels in die Swartland te verfyn is tans onderweg. Die potensiële invloed wat grond op verskeie faktore soos grondvog, N-mineralisasie en die daaropvolgende gewasprestasie kan uitoefen, is gedurende die 2007-produksieseisoen waargeneem. In hierdie artikel sal die koring/medic-klawer/koring/medic-klawer stelsels (kampe 44 en 55) vergelyk word. Die afstand tussen hierdie kampe is ongeveer 300m, maar, alhoewel koring in identiese wisselboustelsels vergelyk word, is aansienlike verskille in gewasprestasie waargeneem.

Tabel 1 Plant- en opbrengskomponente van koring die 000 (geen N bemesting) persele in kampe 44 en 55 te Langgewens navorsingsplaas gedurende die 2007 koringgroeiseisoen.

	Kamp 44	**Kamp 55**
Planthoogte (mm)	839.99	728.15
Aarlengte (mm)	113.41	101.96
Are/m^2	238.82	152.74
Korrels/aar	44.73	36.8
Duisendkorrelmassa (g)	45.54	49.71
Strooi	5721.7	3297.1
Graan	4362.7	1977.2

Plant N-inhoud (%)
Die N-inhoud van die koringplante in kamp 44 was sonder uitsondering, tydens alle groeistadia, hoër as in kamp 55 (Figuur 1).

2. Doel

Die doel van hierdie artikel is dus om vas te stel wat die oorsaak is dat twee kampe wat reeds vir meer as 10 jaar identies bestuur word, grootliks verskil in die vermoë om hoë koringopbrengste te lewer. Om die bespreking te vereenvoudig, word slegs braakpersele (geen koringplante) en persele waar geen N aan die koring toegedien is nie (geen N persele) bespreek. Die effek van toegediende N word sodoende uitgesluit.

3. Resultate en bespreking

Opbrengs en opbrengskomponente

Graanopbrengs van die geen N behandelings in kamp 44 was 2385.5 kg hoër as in kamp 55 (Tabel 1). Die hoër opbrengs in kamp 44 kan toegeskryf word aan die groter aantal are/m2 (238.82 in kamp 44 teenoor 152.74 in kamp 55) en meer korrels per aar (44.73 teenoor 36.8). Alhoewel die koring in kamp 55 swaarder korrels (1000 korrel massa) ontwikkel het, kon dit nie genoegsaam kompenseer vir die lae korrelgetal en aantal are/m2 nie.

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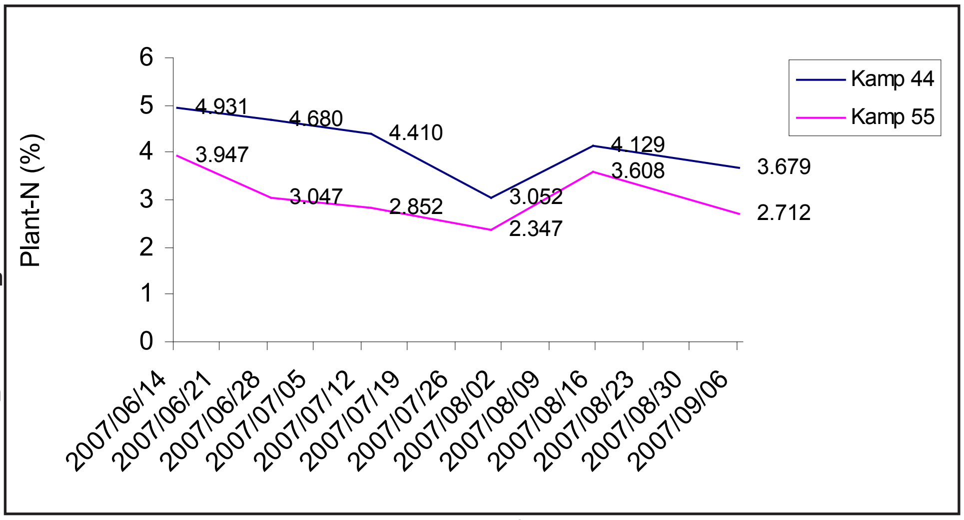
Tabel 1 toon duidelik dat die plante in kamp 44 baie meer biomassa geproduseer het. Hierdie plante was aansienlik hoër (839.99mm teenoor 728.15mm) en het gevolglik meer strooi/ha (5721.7 teenoor 3297.1 kg) gelewer.

Die stikstofkonsentrasie in die plantmateriaal gemonster in kamp 55 word meesal as marginaal tot tekort geklassifiseer (Reuter en Robinson (1997). Die krities lae plant N-vlakke wat veral vroeg in die seisoen in kamp 55 waargeneem is kon grootliks bydra tot die laer graanproduksie as gevolg van opbrengskomponente (are/m2 en aantal korrels/aar) wat as gevolg van 'n waarskynlike N-tekort nie tot volle potensiaal kon ontwikkel nie. Aangesien biomassaproduksie in kamp 44 hoër as in kamp 55 is (Tabel 1), en plant N as persentasie uitgedruk word, kan aangeneem word groter hoeveelhede N (g) deur die koring in kamp 44 vanuit die grond opgeneem is.

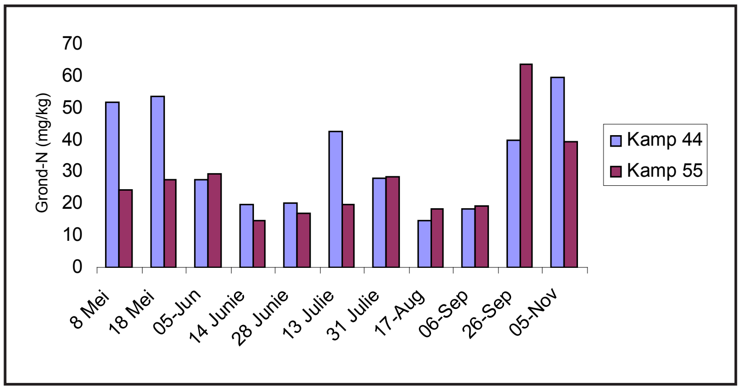


Figuur 1 Plant-N inhoud (%) van die 000 (geen N bemesting) persele in kampe 44 en 55 te Langgewens navorsingsplaas gedurende die 2007 koringgroeiseisoen.

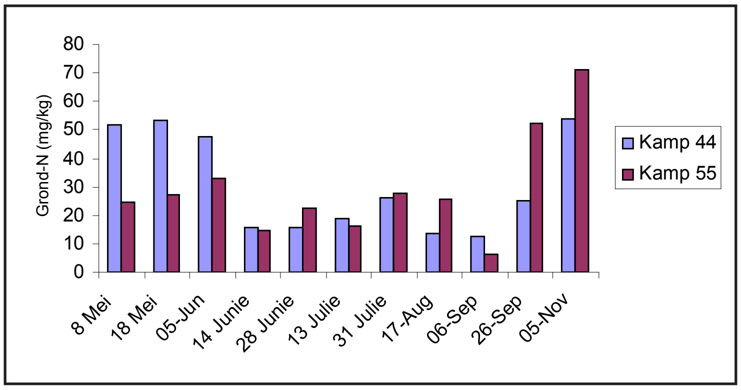
Grond-N

Grond-N is bepaal deur die boonste 200mm van die grondprofiel gedurende die groeiseisoen te monster. Alhoewel beide kampe uit 'n peulgewasweidingsfase in die stelsel kom, is duidelike verskille in N-mineralisasie waargeneem. Die N-inhoud (NH4-N + NO3-N) van die braakpersele in kamp 44 is, met die uitsondering van 26 September, hoër as in kamp 55 (Figuur 2).

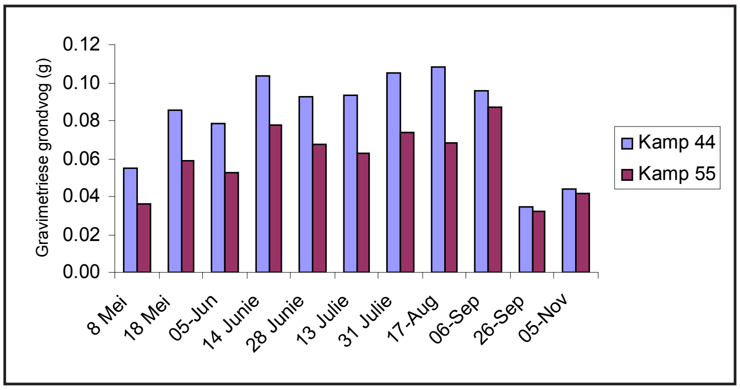
Figuur 3 (geen N) toon duidelik dat 'n hoër grond-N inhoud gedurende die eerste 30 dae na plant (koring is op 9 Mei 2007 in nat grond geplant) in kamp 44 waarskynlik 'n hoër opbrengspotensiaal vasgelê het. Die hoër grond-N in kamp 55 gemeet op 26 September kon moontlik aanleiding gegee het tot die swaarder korrels (Tabel 1) geproduseer. Die laer grond-N vlakke in kamp 44 gemeet tussen 17 Augustus en 5 November kon die gevolg wees van groter hoeveelhede stikstof opgeneem deur die groter biomassa soos afgelei uit Tabel 1. Afgesien van die hoër korrelgewig, kon die koring in kamp 55 nie die hoër grond-N benut om graanproduksie te verhoog nie, waarskynlik nét om die bestaande potensiaal te behou. Die relatief hoër grond-N vlakke in beide kampe op 26 September en 5 November dui op verhoogde N-mineralisasie as gevolg van stygende grondtemperature.



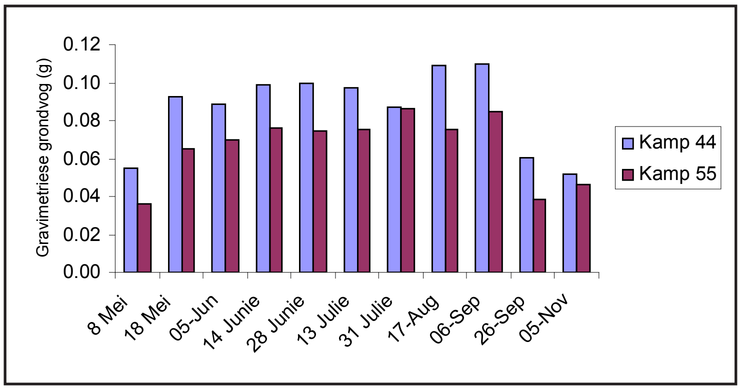
Figuur 2 Grond-N inhoud (mg/kg) van die braakpersele in kampe 44 en 55 te Langgewens navorsingsplaas gedurende die 2007 koringgroeiseisoen.



Figuur 3 Grond-N inhoud (mg/kg) van die 000 (geen N-bemesting) persele in kampe 44 en 55 te Langgewens navorsingsplaas gedurende die 2007 koringgroeiseisoen.



Figuur 4 Gravimetriese waterinhoud (g) van die braakpersele in kampe 44 en 55 te Langgewens navorsingsplaas gedurende die 2007 koringgroeiseisoen.



Figuur 5 Gravimetriese waterinhoud (g) van die 000 (geen N-bemesting) persele in kampe 44 en 55 te Langgewens navorsingsplaas gedurende die 2007 koringgroeiseisoen.

Gravimetriese grondvoginhoud

Die gravimetriese grondvoginhoud is bepaal deur die vergelyking:

Gravimetriese grondvoginhoud = (grond nat massa – grond droë massa)/droë massa

Figure 4 en 5 toon duidelik die verskil in grondwatervlakke tussen die braak persele en geen N persele onderling aan.

Uit bostaande grafieke is dit duidelik dat in beide braak en persele waar koring geen N-bemesting ontvang het nie, was die voginhoud van die grond hoër in kamp 44. Hierdie voordeel het oor die hele groeiseisoen gestrek. Die laer voginhoud van 55 kon dus die voorsiening en opname van, onder andere N, aan die koringplant beperk het.

Grondtemperatuur

Grondtemperatuur is op ‘n gronddiepte van 150 mm gemeet. Meting het op 18 Mei in aanvang geneem. Die relatief hoë grondtemperature gedurende September en Oktober in kombinasie met beskikbare grondvog (Figuur 5), was verantwoordelik vir die toename in grond-N vlakke (Figure 2 en 3).

Grondeienskappe

Geselekteerde fisiese en chemiese eienskappe van die grond in kampe 44 en 55 word in Tabel 3 vervat.

Uit Tabel 3 is dit duidelik dat die grondfisiese eienskappe drasties verskil. As gevolg van die relatief hoër klip- en sandfraksies sal verwag word dat voghouvermoë van die grond in kamp 55 laer sal wees as in kamp 44. Hierdie aanname word bevestig deur die data vervat in Figure 4 en 5. Die vermoë van die gewas om sekere elemente soos stikstof en swawel op te neem, word sterk beïnvloed deur die voginhoud van die grond (Brady, 1990; Tisdale & Nelson, 1975; FSSA,1989). Aangesien stiktof hoofsaaklik deur massavloei opgeneem word (FSSA, 1989), sal lae grondwaterinhoud noodwendig lei tot N tekorte. Met laer voginhoude wat absorpsie van N en S kan beperk, is dit hoogs waarskynlik dat hierdie elemente tyens kritieke groeistadia beperkend kon raak (Figuur 1) en opbrengs dienooreenkomstig verlaag.

4. Gevolgtrekking

Alhoewel die artikel net neigings bespreek, kan die effek van grond duidelik op die voginhoud, N-mineralisasie en gevolglike plantprestasie waargeneem word. Die feit dat kamp 44 ‘n laer klip- en hoër slik- asook kleifraksie bevat, het tot gevolg dat meer grondvog in die wortelsone beskikbaar is in vergelyking met kamp 55. Meer vog is beskikbaar vir plantopname en massavloei van N na die wortels verseker dat voldoende N deur die wortels opgeneem kan word. Die opbrengspotensiaal van kamp 44 is dus hoër as kamp 55. In praktyk behoort die N bemestingsprogram in kamp 44 dus ietwat te verskil van kamp 55 omdat die opbrengspotensiaal verskil, alhoewel beide identies in die stelsel bestuur word.

5. Verwysings

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Tabel 2 Grondtemperature (ºC) gemeet op ‘n gronddiepte van 150 mm in die stelselproef te Langgewens (2007).

Maand	ºC
Mei	13.8
Junie	12.6
Julie	11.5
Augustus	12.3
September	14.9
Oktober	20.7

Tabel 3 Geselekteerde fisiese en chemiese eienskappe van die grond in kampe 44 en 55 wat deel vorm van die stelselproef te Langgewens (2007).

Parameter	Kamp 44	Kamp 55
Klip (%)	34-37	52-55
Sand (%)	69	79
Slik (%)	14	11
Klei (%)	17	10
C (%)	0.53	0.47
N (%)	0.11	0.08
S (mg/kg)	13.17	8.31

Rumen inert fat or starch as supplementary energy sources for reproducing ewes grazing wheat stubble

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Abstract
A trial was conducted to determine the efficiency of utilization of rumen inert fat as a supplementary energy source for reproducing South African Mutton Merino (SAMM) ewes (n = 56) grazing wheat stubble. The ewes were randomly divided into four groups of 14 ewes each, with every group representing a treatment. The wheat stubble paddock was divided into four paddocks of equal sizes, and the ewes grazed these paddocks at a stocking density of 4.6 ewes/ha from the 1 November 1992 until May 1993 after the break of the season. The ewes were rotated between the paddocks on a weekly basis. Each group received 250 g of supplementary feed per head daily for the last six weeks of pregnancy, and this was increased to 360 g during the first four weeks of lactation. Supplementation was supplied on Mondays, Wednesdays and Fridays for a 70-day period. Supplementary feed contains either inert fat, starch (maize meal), a combination of inert fat and starch or wheat bran as an energy source. The crude protein (CP) content of the supplements varied between 16.7 % and 19.6 %. No significant difference ($P > 0.05$) occurred between the live weights of ewes during the last six weeks of pregnancy, the first four weeks of lactation, or the total feeding period. The ewes receiving the 50 % fat plus 50 % maize meal tended to lose less weight ($P \leq 0.08$) during lactation than the ewes that received maize meal as their main energy source. No significant difference occurred in the absolute live weight of ewes over the experimental period. A lack of response to inert fat as supplementary source in the live weight of the ewes was observed during the total experimental period, when compared to the control group which received wheat bran.

Introduction
Wheat stubble is the dominant forage available during summer in the Mediterranean sheep farming areas of South Africa, like the Swartland region. Europe produces about 330 million tons of cereal straw annually (Cañeque *et al*., 1998), and about 460 000 ha of wheat stubble are available in South Africa annually (Brand, 1996). During the early summer period, cereal stubble generally provides adequate nutrition for sheep, but serious deficiencies may occur during the late summer, autumn and early winter months (Brand *et al*., 2000). Autumn and winter lambing seasons are followed in this region, which implies that ewes in the critical physiological stages of pregnancy and lactation are dependent on wheat stubble. However, wheat stubble contains low levels of carbohydrates and nitrogen, has a poor digestibility and high cell wall content (Dann & Coombe, 1987). This implies that wheat stubble is unable to meet the high nutrient requirements of the reproducing ewe (Aitchison, 1988; Brand *et al*., 1997), and therefore supplementary feed is essential. The low digestibility of wheat stubble as well as the decrease in the physical capacity of the rumen of the pregnant ewe, results in a reduced intake of available wheat stubble (Mulholland *et al*., 1976). Therefore, the aim of supplementing the diet is to correct ruminal and animal deficiencies in the diet (Dann & Coombe, 1987). In a study by Gomes *et al*. (1994) it was indicated that by including a rapidly fermentable carbohydrate like maize meal in the diet of ewes grazing wheat stubble, the energy supply could be successfully supplemented. A higher live weight was also obtained with pregnant and lactating ewes that received cereal supplements while grazing wheat stubble compared to an unsupplemented group (Cloete & Brand, 1990). Fats represent an excellent source of dietary energy for inclusion in ruminant diets. It contains an average of 37 MJ/kg gross energy, all of which is available as digestible energy, and about 0.80 of which (30 MJ/kg) is available as net energy. The efficiency of utilization of dietary lipid for body fat synthesis is also more than double that of carbohydrates (Thornton & Tume, 1984). The energy density of a diet can be increased without reducing forage to concentrate ratio (Grummer *et al*., 1990) by the inclusion of fats in the diet. On the other hand, fat has the disadvantage of reducing the digestibility of fibre in the rumen when it is fed in excess of 2-3 % of the feed dry matter (Palmquist, 1988), because it protects fibre from being fermented (Harfoot *et al*., 1974), as well as being toxic to cellulolytic bacteria (El Hag & Miller, 1972). Holter *et al*. (1993) found that when lactating dairy cows were supplemented with a bypass protein-fat supplement, forage and total dry matter intake (DMI) were reduced significantly, which negated the potential nutritional value of the supplement. Therefore, if more than 6 % fat is to be included, it must either be protected from ruminal fermentation or converted to soaps (Palmquist & Jenkins, 1982; Kotzè, 1992) if they are to be used as supplements in ruminant diets. Depending on the diet, fat may contribute 7-10 % of the digestible energy in the rumen (Ruckebusch & Thivend, 1980). The high acidity in the duodenum combined with detergent action of bile acids, lysolecithin and fatty acids causes saturated fatty acids to be more digestible in ruminants than in non-ruminants (Palmquist & Jenkins, 1980).

A trial was conducted to quantify the effect of rumen inert fat, maize meal or a combination of these energy sources in combination with a low degradable protein source as supplementary feed for pregnant and lactating ewes when grazing wheat stubble.

Materials and Methods
A trial was conducted at the experimental farm, Langgewens, in the Swartland area of the winter rainfall region of South Africa (33°17′S, 18°42′E, altitude 177m). Fifty-six South African Mutton Merino (SAMM) ewes were synchronized with Repromap® (medroxyprogesterone acetate, 60 mg) sponges and then mated from 1 November 1992. The ewes grazed wheat stubble for five months at a stocking density of 4.6 ewes/ha. The ewes were randomly divided into four paddocks of equal sizes, and rotated between paddocks on a weekly basis. Each ewe received 250 g supplementary feed daily for the last six weeks of pregnancy and during the first four weeks of lactation this was increased to 360 g per ewe. The supplementary feed mixtures contained a standard amount of molasses and fishmeal with either wheat bran (control group), maize meal, bypass fat or a combination of maize meal and bypass fat as an energy source. The rumen inert fat source was Morlac® (Marine Oil Refiners, Dido Valley, Simon's Town, RSA). The supplementary feed was provided as licks in troughs on Mondays, Wednesdays and Fridays, and the ewes were weighed every fortnight. The experi-

ment ended in May after the break of the season.

An analysis of variance was used to detect differences in live weight changes in the different groups of ewes. The live weight of the ewes was used as a covariant at the onset of the experiment, to correct subsequent live weight data by analysis of covariance (Statgraphics 5.0, 1991). The physical composition of the four diets received by the ewes for 70 days are presented in Table 1.

Results and Discussion

The chemical composition and total digestible nutrient (TDN) content of the supplements are presented in Table 2. The crude protein (CP) concentration of the diet varied between 16.7 % and 19.6 %, whereas the TDN concentration varied between 52.0 % and 76.7 %.

The live weight changes of the SAMM ewes over the 150-day trial period are presented in Table 3. It is evident from Table 3 that no significant differences (P > 0.05) were observed between the live weight of ewes during the last six weeks of pregnancy, the first four weeks of lactation, or the total feeding period. The ewes in the group that received 50 % fat plus 50 % maize meal lost less weight than the ewes that received maize meal as their main energy source ($P \leq 0.08$). There was also no significant difference in the live weight change (LWC) of ewes over the experimental period (Figure 1). Similar to our results, Horton *et al*. (1992) found that Ca soaps had no effect on apparent digestibility of organic matter (OM), CP or crude fibre (CF) when fed to lactating ewes.

In the study by Horton *et al*. (1992) it was also found that with the inclusion of rumen inert fat at 7.5 to 29.6 % of NRC (1985)

Table 1: Ingredient composition of four supplements presented as supplementary licks to SA Mutton Merino ewes during the last six weeks of pregnancy and the first four weeks of lactation while grazing wheat stubble for 150 days at a stocking density of 4.6 ewes/ha

Raw materials	Treatments			
	Control	**Maize meal**	**Bypass fat (Morlac®)**	**50 % Bypass fat plus 50 % maize meal**
Molasses	50	50	50	50
Fishmeal	50	50	50	50
Wheat bran	100	0	50	25
Maize meal	0	100	0	50
Bypass lipids (Morlac®)	0	0	50	25
Salt	50	50	50	50
Total (kg)	250	250	250	250

Table 2: Calculated chemical composition on an air dry basis (%) of supplementary feed sources provided to SA Mutton Merino ewes grazing wheat stubble

Composition	**Supplements**			
	Control	**Maize meal**	**50 % Bypass fat plus 50 % maize meal**	**Bypass fat (Morlac®)**
Crude protein	19.60	17.21	16.96	16.70
Crude fibre	5.60	2.36	2.88	3.40
Total digestible nutrients	52.00	60.40	68.50	76.60
Calcium	1.12	1.07	1.09	1.10
Phosphorus	0.95	0.68	0.73	0.77

Table 3: *Live weight changes (kg) of SA Mutton Merino ewes during the feeding period (November 1992 until May 1993)*

Item	**Live weight change**					
	Control	**Maize meal**	**Bypass fat**	**50 % Bypass fat plus 50 % maize meal**	**SEM**	**P**
Initial bodyweight	73.9	73.9	73.9	73.9	1.0	0.71
Final bodyweight	68.2	64.9	68.4	69.5	2.0	0.31
Weight change:						
Last six weeks of pregnancy	+4.5	+4.2	+5.8	+4.3	0.5	0.70
First four weeks of lactation	-9.2	-12.3	-10.5	-7.6	0.7	0.08
Total feeding period (10 weeks)	-4.6	-8.1	-4.8	-3.3	0.9	0.28

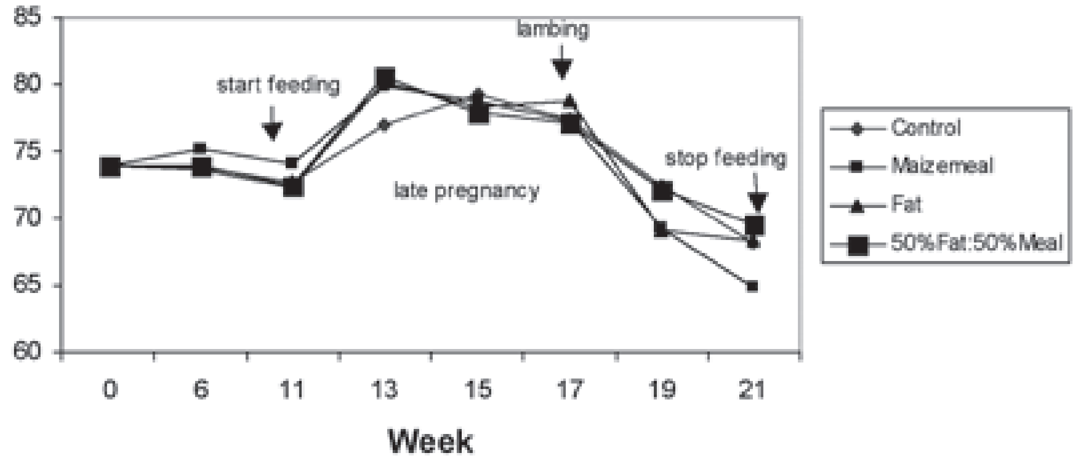

Figure 1. Live weight of SA Mutton Merino ewes grazing wheat stubble for 150 days at a stocking density of 4.6 ewes/ha and supplemented with different energy sources during late pregnancy and early lactation.

energy requirements of lactating ewes no effect on bodyweight changes of lactating ewes or their lambs was noted. Failure of rumen inert dietary lipid to improve weight change in lactating ewes may be due to its effect on forage consumption and fat absorption.

When compared to the control group, which received wheat bran as supplement, the experiment indicated a lack of response in the live weight of the ewes due to supplementary maize meal and rumen inert fat. Wheat bran is a high-quality product (13.5-15 % CP; Boucque & Fiems, 1988), probably matching responses achieved by either maize meal of rumen inert fat. In a study by Horton *et al*. (1992) it was also concluded that in spite of increasing the energy density of the diet, hay intake and fat absorption were depressed by the inclusion of rumen inert fats, and therefore no beneficial effects of lactating ewes on milk production, milk composition, bodyweight change in ewes or nursing lambs were found. In contrast to these results Sklan (1992) found that live weight of ewes increased after lambing from 65.4 kg to 75.1 kg at 90 days in ewes given calcium soaps of fatty acids (CSFA). In a study by Perez-Hernandez *et al*. (1986), it was found that each of twin lambs reared by ewes receiving a basal diet containing 145 g CP and 10 MJ metabolizable energy (ME) per kg dry matter with a lipid source, supplemented with 200 g/day of the lipid source, were on average 1.0 kg heavier at 5 weeks of age than those from ewes receiving the basal diet alone.

Conclusion

A lack of response in ewe live weight due to supplementary maize meal and bypass fat was indicated by this study, which shows that supplementary energy either in the form of starch or rumen fat was without advantages in this study. In a study done by Cronjè & Oberholzer (1990) it was also found that supplementation with as little as 100 g/d whole maize reduced roughage intake due to substitution. Animal response to supplementary feed is however to a great extent also dependent on the quality of the available pasture and production results due to supplementation may change according to pasture quality. The main reason for a lack of response on the starch containing a bypass fat as found in this study may probably be due to the fact that wheat bran provided in the control group probably matched responses achieved by the test sources.

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